MI/EGLE/WRD-20/023

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

FISH CONTAMINANT MONITORING PROGRAM

2019 ANNUAL REPORT

A SUMMARY OF EDIBLE PORTION SAMPLING EFFORT AND ANALYTICAL RESULTS WITH RECOMMENDATIONS FOR UPDATES TO THE MICHIGAN DEPARTMENT OF HEALTH AND HUMAN SERVICES' EAT SAFE FISH GUIDE

OCTOBER 2020

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SECTION 1.0

INTRODUCTION

The Michigan Department of Environment, Great Lakes, and Energy-Water Resources Division (EGLE-WRD) has measured contaminants in over 20,000 fillet or other edible portion fish tissue samples collected since 1980. Fish contaminant analyses are limited to chemicals with high bioaccumulation potential in fish tissue. The presence of even extremely low concentrations of some bioaccumulative pollutants in surface water can result in fish tissue concentrations that pose a human or wildlife health risk. The EGLE-WRD conducts fish contaminant monitoring to address four goals:

1. The first goal is to support the development of the Michigan Department of Health and Human Services (MDHHS) *Eat Safe Fish Guide*. Edible portion sample results are used by the MDHHS to issue general and specific consumption advisories for sport-caught fish from Michigan's surface waters.
2. The second goal is to support the regulation of commercial fisheries in the waters of the state. The Michigan Department of Agriculture and Rural Development (MDARD) uses edible portion monitoring results to regulate sales of the commercial catch.
3. The third goal of the fish contaminant monitoring is to identify spatial differences and temporal trends in the quality of Michigan's surface waters. Temporal trends and spatial differences are examined by collecting whole fish, passive sampler, and caged fish samples in addition to the edible portion samples.
4. Finally, the fourth goal is to evaluate whether existing pollution prevention, regulatory, and remedial programs are effectively reducing chemical contamination in the aquatic environment. To achieve this goal, fish tissue samples are used to identify waters that are attaining or not attaining the designated uses described in Michigan's Water Quality Standards (WQS), identify sources of pollutants, and track the effectiveness of remedial actions.

Prior to 1986, Michigan conducted fish contaminant studies on an as needed basis primarily to address specific problems. In 1986 a comprehensive plan was initiated to assess the degree of chemical contamination in fish from the surface waters of the state. EGLE uses three sampling elements to meet the goals of the monitoring program:

1. Edible portion sampling is often targeted toward sites of known or suspected contamination, sites popular with sport anglers, and sites with public access. Results from the analysis of edible portion samples are used to develop recommendations for updates to the MDHHS *Eat Safe Fish Guide* and to identify water bodies that are supporting and not supporting the fish consumption designated use described in the WQS.
2. Temporal trends in contaminant concentrations are assessed by analyzing whole fish samples collected every three to five years from 22 Great Lake, connecting channel, or inland water body locations.
3. Caged fish or passive water samplers are used to identify sources of bioaccumulative contaminants and to identify spatial trends in contaminant concentrations.

This report summarizes edible portion analytical results obtained since the last Fish Contaminant Monitoring Program (FCMP) annual report (Bohr, 2017), including all analytical results obtained by December 31, 2019.

Several state and federal agencies and tribal organizations assist with the EGLE-WRD fish contaminant monitoring efforts by collecting or analyzing samples and data. These include the

Michigan Department of Natural Resources-Fisheries Division (MDNR-FD), MDHHS, MDARD, United States Environmental Protection Agency (USEPA), United States Fish and Wildlife Service, Grand Traverse Band of Ottawa and Chippewa Indians, Chippewa Ottawa Resource Authority, Keweenaw Bay Indian Community, Little Traverse Bay Bands of Odawa Indians, and the Great Lakes Indian Fish and Wildlife Commission. In addition, sample collection plans and analytical results are reviewed by Michigan's Fish and Wildlife Contaminant Advisory Committee (FAWCAC). The FAWCAC members include representatives from all Michigan agencies involved in fish and wildlife contaminant monitoring (EGLE-WRD, MDHHS, MDARD, and MDNR). The primary role of the FAWCAC is to coordinate fish and wildlife monitoring conducted by state agencies. Also, the FAWCAC reviews fish and wildlife consumption advisories proposed by state agencies in Michigan.

Michigan's fish contaminant data have been compiled into a large database and are available by contacting the FCMP coordinator. Summaries of contaminant data are available in staff reports (MDNR, 1986a, 1986b, and 1989; Duling, 1988; Duling and Benzie, 1989 and 1990; Saalfeld et al., 1991; Waggoner, 1992; Wood, 1993 and 1994; Wood et. al., 1995; Day and Holden, 1996; Day, 1997, 1998, 1999, and 2002; Day and Walsh, 2000 and 2001; Day et al., 2004; Day and Bohr, 2005; Bohr and Zbytowski, 2006, 2007, 2008, Bohr and VanDusen, 2009, 2011a, 2011b, and Bohr, 2015, 2016, 2017). An inventory of samples analyzed in fiscal years (FY) 2017, 2018, and 2019 is presented in Appendix A. A summary of contaminant monitoring locations and species sampled between 1980 and 2019 with fish analyzed as edible portion samples listing contaminants causing consumption advice is provided in Appendices B and C.

SECTION 2.0

METHODS

2.1 FISH COLLECTION AND EDIBLE PORTION PROCESSING

The MDNR-FD and EGLE-WRD collected the majority of the fish using standard fish sampling techniques determined to be appropriate for individual water bodies. These techniques included electrofishing, trap nets, gill nets, and trawling. In addition, private consultants and tribal organizations have collected samples for the program.

The EGLE-WRD processed fish in accordance with the Surface Water Assessment Section Procedure WRD-SWAS-004 (available upon request). Total length and weight were recorded for each fish. Fish were prepared as standard edible portions (Table 1). Each sample was individually wrapped in aluminum foil, labeled, and held frozen until analyzed.

Over 20,000 edible portion samples have been analyzed by EGLE-WRD since regular fish contaminant monitoring began in 1980. This report summarizes the analyses of all the edible portion samples in the EGLE database, with detailed emphasis on the samples of 2,105 fish of 23 species from 178 locations analyzed in FYs 2017-2019. The edible portion sampling locations, species, and number of samples analyzed in that period are listed in Appendix A. Edible portion sampling was often targeted toward sites of known or suspected contamination, sites popular with sport anglers, and sites with public access. Analytical costs were covered by State of Michigan legislative appropriations, USEPA Great Lakes Restoration Initiative grants, Natural Resource Damage Assessment funds, and Consent Agreement assessments for specific projects.

2.2 CHEMICAL ANALYSES

Analysis of the FCMP fish tissue samples was conducted by the MDHHS-Analytical Chemistry Laboratory (ACL) (previously the Michigan Department of Community Health laboratory); historically, certain analyses were conducted by the MDNR, MDARD, USEPA, or one of several contract laboratories as needed. Current and past analytical laboratories all have quality assurance programs and use peer-reviewed methods of digestion, extraction, and quantitation. Table 2 lists the standard contaminants measured in most fish tissue samples. All results are reported to EGLE as wet weight concentrations.

Prior to 2000, polychlorinated biphenyls (PCB) were reported as total Aroclors; subsequent samples were analyzed using a congener detection method with results for a total of 83 congeners either individually or as co-eluting congeners (Table 3).

Analyses of chlorinated dibenzo-p-dioxin, dibenzofuran (Table 4a), and coplanar PCB congeners (Table 4b) were performed on a subset of edible portion samples. The analysis of coplanar PCB (dioxin-like) congeners in EGLE fish samples began in 2003 and has been part of the dioxin analysis in edible portion samples since 2007. Pace Analytical Laboratories analyzed the dioxin-like congeners under a subcontract with the MDHHS-ACL between 2006 and 2011; the MDHHS-ACL began analysis of those compounds in 2012.

Mercury was measured as total mercury by thermal decomposition, amalgamation, and atomic absorption spectrometry.

Selenium samples were analyzed in selected samples by the MDHHS-ACL using techniques based on the USEPA Method 200.11.

Perfluorinated compounds (PFC) in fish tissue were measured by the MDHHS-ACL by Reversed Phase High Performance Liquid Chromatography Multiple Reaction Monitoring Tandem Mass Spectrometry. A total of 16 PFCs can be quantitated in edible portion samples with the method used by the MDHHS-ACL (Table 5). Five of those compounds are not generally reported out since they have not been quantitated in fish tissue.

The standard MDHHS-ACL analytical method for toxaphene can identify a residue with chromatographic characteristics similar to toxaphene but does not specifically identify the residue as the pesticide toxaphene. Those results are referred to as "apparent toxaphene." The MDHHS-ACL Limit of Quantitation (LOQ) for apparent toxaphene is 0.05 parts per million (ppm) (Table 2), which is higher than several of the MDHHS Fish Consumption Screening Values (FCSV). This means that we cannot identify fish populations with apparent toxaphene concentrations that would lead to a consumption recommendation of more than four meals per month. Recently the MDHHS-ACL has developed an analytical method (Parlar Method) that provides precise measurements of the concentrations of several toxaphene congeners (Parlars 26, 40, 41, 44, 50, and 62) as well as the toxaphene degradation products commonly referred to as Hx-Sed and Hp-Sed. Due to the higher cost of this analytical method it is used selectively on sample sets with relatively high apparent toxaphene concentrations. Toxaphene Parlars 26, 50, and 62 are the most likely of those compounds to accumulate in fish and represent about 90% of toxaphene measured in humans (MDHHS, 2009). Toxaphene results using the Parlar Method are reported here as the total of the three congeners and listed as Toxaphene $\Sigma 3PC_{26,50,62}$ (or Tox Σ3PC).

Finally, the MDHHS-ACL does not report contaminant concentrations below the quantitation level (QL), but above the detection level (DL) for mercury, selenium, or the organic parameters listed in Table 2. As a result, concentrations of these parameters that are below the QL are coded with a "K" in the FCMP database. In these cases, the "K" coded concentrations represent the MDHHS-ACL QLs. However, "K" codes assigned to dioxin, furan, and PCB congeners indicate that concentrations were below the DL while "J" or "NQ" codes indicate that concentrations were above the DL, but did not meet all of the quantitation requirements. The "J" code was used when analytical laboratory scientists decided the divergence from quantitation requirements was not significant; in these cases, the "J" coded concentrations are treated the same as uncoded results. The "NQ" coded concentrations are treated as null results.

2.3 SUMMARY STATISTICS

Total PCB concentration was estimated by summing the concentrations of the PCB congeners listed in Table 3. Individual congeners below the DL were assigned a concentration equal to zero for the purpose of calculating a total PCB concentration. Also, congener analyses that did not meet retention time criteria or were subject to analytical interference were assigned a concentration equal to zero for the purpose of calculating a total PCB concentration. If the results of an individual congener analysis did not meet all quantitation requirements (flagged "J"), then the congener was assigned a concentration equal to the estimated concentration for the purpose of calculating a total PCB concentration. If all of the congeners were below the DL, then the total PCB concentration was reported as less than the highest DL of the individual congeners (1 microgram per kilogram [part per billion (ppb)]).

Total chlordane concentration was estimated by summing the concentrations of five chlordane breakdown products: *alpha*-chlordane, *gamma*-chlordane, *cis*-nonachlor, *trans*-nonachlor, and oxychlordane. Individual compounds below the QL were assigned a concentration equal to zero for the purpose of calculating a total chlordane concentration. If all five compounds were below the QL, then the total chlordane concentration was reported as less than the QL of the individual compounds.

Total dichlorodiphenyl trichloroethane (DDT) concentrations were calculated by summing concentrations of the para, para' and ortho, para' forms of the following chemicals: DDT, dichlorodiphenyl dichloroethane (DDE), and 1,1-bis(4-chlorophenyl)-2,2-dichloroethane (DDD). Individual chemicals below the QL were assigned a concentration equal to zero for the purpose of calculating a total DDT concentration. If all six components were below the QL, then the total DDT concentration was reported as less than the lowest QL of the metabolites.

Total 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxic equivalents (TEQ) were calculated using the USEPA recommended toxic equivalency factors for seven dioxin, 10 dibenzofuran, and 12 dioxin-like PCB (dl-PCB) congeners (USEPA, 2010). The concentrations of individual dioxin, dibenzofuran, and dioxin-like PCB congeners in a fish sample were multiplied by toxic equivalency factors; the resulting products were summed to calculate a 2,3,7,8-TCDD TEQ concentration. Any individual congener concentrations less than the DL were assigned a value of zero for the purpose of calculating the dioxin TEQ. The MDHHS began including the 12 dioxin-like PCB congeners in the calculation of TEQ for the 2008 Fish Consumption Advisory; prior to that the TEQs were calculated using only the 17 dioxin and dibenzofuran congeners.

2.4 FISH CONSUMPTION SCREENING VALUES AND "EAT SAFE FISH" GUIDANCE DEVELOPMENT

The MDHHS is responsible for establishing, modifying, or removing sport fish consumption advisories in Michigan. The MDHHS toxicologists develop FCSVs based on a review of the best available scientific literature about the adverse health effects associated with a chemical of concern. The MDHHS has established FCSVs for mercury, total PCBs, dioxin TEQ, total DDT, one PFC (perfluorooctane sulfonate [PFOS]), selenium, and toxaphene for use in developing meal category guidance (Table 6). Supporting documentation for those FCSVs can be found online at Michigan.gov/MDHHS/0,5885,7-339-71548_54783_54784_54785-170340--,00.html.

Fish consumption guidance is developed based on an evaluation of the relationship between contaminant concentrations and screening values across all size ranges of a given species of fish taken from specific locations. Where possible, linear regression analyses of fish length versus contaminant concentrations are used to predict lengths at which the concentrations in fish species are likely to exceed screening values. When regression analysis indicates a positive slope with a correlation coefficient (R^2) greater than 0.6, the MDHHS uses the regression line to estimate the contaminant concentration in fish between the minimum and maximum lengths represented in the dataset. The estimated concentration at a range of lengths is compared to the FCSV ranges.

However, contaminant concentrations and fish total length data often do not conform to the underlying assumptions of linear regression, or the line does not meet the minimum R^2 required by the MDHHS. In these cases, the appropriate advisory is determined using the upper 95% confidence limit (95% UCL) on the mean concentration measured in a minimum of five fish of legal size. Fish will shrink a significant amount due to freezing; since FCMP fish are held frozen prior to being measured, those fish within ½-inch of the minimum legal size limit are considered to be legal size for the calculation of the 95% UCL.

The MDHHS prefers a dataset with a minimum of ten samples before establishing or modifying fish consumption advisories. However, best professional judgment is applied when evaluating smaller datasets. Additional details can be found in the *Michigan Fish Consumption Advisory Program Guidance Document* (MDHHS, 2016).

The MDHHS Eat Safe Fish Guide divides the state into five regions listing guidance for water bodies by county within those regions. The five regions include the Upper Peninsula (UP) and four quadrants in the Lower Peninsula (Figure 1). Each of the regions has a separate pamphlet style guide (available online at Michigan.gov/EatSafefFsh [*Going Fishing?* button]). Guidance for the Great Lakes and connecting channels that adjoin those five regions is included in the appropriate regional guides. The Web page noted above also has a *Reports & Science* button that provides links to the Fish Consumption Data and Recommendation sheets that were used to develop specific guidance.

SECTION 3.0

RESULTS AND DISCUSSION

This report summarizes the analytical results available by December 31, 2019, for edible portion fish samples collected primarily in 2016 through 2019. A total of 2,105 edible portion fish tissue samples collected during that time period are summarized in this report. This includes samples of 23 species from 178 locations in a total of 58 inland lakes, 18 impoundments, 21 rivers, and all of the Great Lakes and connecting channels bordering Michigan. Detailed summaries of the data used for "Eat Safe Fish" guidance are available online at Michigan.gov/EatSafeFish (*Reports & Science* button) or by contacting the MDHHS, Division of Environmental Health.

EGLE has conducted 1,628 edible portion fish sampling events at 679 sites in inland waters and 133 sites in Michigan waters of the Great Lakes and connecting channels between 1980 and 2019 (Tables 7 and 8). Over 20,400 edible portion samples have been analyzed to date; those results are also summarized.

3.1 General Highlights for Samples Collected and Analyzed in FYs 2017-2019

- Mercury was measurable in every sample analyzed in FYs 2017-2019 (Table 9). The highest concentrations were found in top predator species from inland lakes and impoundments.

- Several of the contaminants analyzed were either below the QL in all of the samples analyzed or measured no higher than the QL; these were aldrin, apparent toxaphene, lindane, heptachlor, heptachlorostyrene, hexachlorostyrene, nickel, pentachlorostyrene, and terphenyl (Table 9). Most of those contaminants have had concentrations near or below the QL in all samples since the start of fish contaminant monitoring in Michigan.

- Dieldrin, a breakdown product of aldrin, was quantified in fish tissue samples from 10 of 27 locations where chlorinated organic compounds were analyzed. Concentrations were very near the QL in most samples (Table 9). Overall, the annual percentage of samples with quantifiable dieldrin has decreased since the start of the FCMP. Beginning in FY 2018 the MDHHS-ACL no longer reports dieldrin results because of the extra cost involved in the analysis.

- Dioxin TEQ concentrations were measurable in every sample from the 16 locations where samples were analyzed for dioxin-like compounds in FYs 2017-2019 (Table 9).

3.2 General Highlights of All Comparisons with MDHHS Screening Values

The following statements are in reference to all edible portion samples analyzed between 1980 and 2019. The summarizations are based on a compilation of guidance for individual water bodies presented in Appendices B and C.

- Mercury levels in fish are elevated enough to cause some level of consumption advice in over 95% of the populations tested statewide and is a primary cause of advisories in over 72% of those populations.

- Mercury is a primary cause of fish consumption advisories for approximately 57% of the fish populations evaluated to date where both mercury and PCBs were analyzed.

- PCBs are a primary cause of fish consumption advisories for 43% of the fish populations evaluated to date where both mercury and PCBs were analyzed; PCBs would cause advisories for 67% of those fish populations if it was the only contaminant of concern.

- Mercury and PCBs cause equivalent consumption advisories in 9% of the fish populations evaluated to date.

- Total DDT is a primary contaminant in 1% of all fish populations sampled to date. All of those populations are in inland waters of the southern Lower Peninsula, and half are associated with the legacy contamination of the Pine River watershed in Gratiot County. In most cases where DDT is a primary cause, mercury, PCBs, or both cause advisories equivalent to the DDT advice. Total DDT would cause advisories in 24% of all fish populations tested if it was the only contaminant of concern.

- Toxaphene is a primary contaminant in three (0.5%) of the fish populations sampled to date, specifically in Glen Lake (Leelanau County) lake trout and Lake Superior siscowet and suckers. At least one other contaminant causes an equivalent advisory in the lake trout and siscowet. In addition, toxaphene would cause advisories for 4% of the fish populations sampled to date if it was the only contaminant of concern.

- Dioxin TEQ has been analyzed in 51 fish populations to date and is a primary cause of fish consumption advisories in 32 (63%) of those populations. Dioxin TEQ would cause advisories for 49 (96%) of the fish populations evaluated to date if it was the only contaminant of concern.

- PFCs were analyzed in 173 fish populations to date. PFOS is a primary cause of fish consumption advisories in 52 (30%) of those populations and would cause advisories in 102 (59%) of those populations if it was the only contaminant of concern.

- Selenium has been analyzed in 36 fish populations to date, primarily in water bodies near iron mining activity in Marquette County. Selenium is a primary cause of fish consumption advisories in two (6%) of those populations and would cause advisories in five (14%) of the populations if it was the only contaminant of concern.

3.3 Summary of Sampling and Screening Value Comparisons for Inland Waters Analyzed in FYs 2017-2019 by Region

This section discusses analytical results for mercury, total PCBs, total DDT, toxaphene (as either apparent toxaphene or Tox Σ3PC), dioxin TEQ, PFOS, and selenium assays conducted on samples collected primarily in 2016, 2017, and 2018 from inland lakes, impoundments, and rivers. These are the contaminants with screening values developed by the MDHHS. The discussion is organized into the five regions of the state used by the MDHHS in the *Eat Safe Fish Guide* (Figure 1).

Summaries for previously reported edible portion data are available online at www.Michigan.gov/EatSafeFish (*Reports & Science* button).

3.3.1 Upper Peninsula

A total of 18 fish populations comprised of nine species from 11 UP water bodies were sampled between 2016 and 2018 (Table 10). A summary of UP contaminant monitoring locations and species analyzed as edible portion samples between 1980 and 2019 is provided in Appendix B1.

Mercury was assayed in all of the UP samples analyzed for this report. Mercury exceeded MDHHS screening values in all 18 populations sampled and is the primary cause of consumption advisories in 17 of the 18 populations.

PCBs and the standard suite of halogenated organic contaminants were assayed in fish from Portage and Torch Lakes (Houghton County), Milwaukee Lake and Silver Lead Creek (Marquette County), and Massie Park Pond (Gogebic County). PCBs without the other halogenated contaminants were analyzed in samples from Big Creek (Marquette County). PCB concentrations exceeded the screening values in fish from Portage Lake, Torch Lake, and Silver Lead Creek.

Apparent toxaphene was assayed in 74 UP fish populations between 2016 and 2019; concentrations did not exceed the LOQ in 71 of those populations. Apparent toxaphene would cause advisories in three UP fish populations if it were the only contaminant of concern.

PFCs were assayed in samples from Big Creek and Silver Lead Creek due to their proximity to the former K.I. Sawyer Air Force Base. PFOS concentrations exceeded the screening values in fish from Silver Lead Creek.

Selenium was assayed in five UP fish populations including largemouth and smallmouth bass from Kingston Lake (Alger County), bluegill and largemouth bass from Milwaukee Lake (Marquette County), and largemouth bass from Shakey Lakes (Menominee County). Selenium concentrations did not exceed MDHHS screening values in those populations.

Dioxin TEQ was not assayed in the samples collected from the UP between 2016 and 2018.

3.3.2 Northwest Lower Peninsula (NWLP)

Six populations comprised of four species from five water bodies in the NWLP were sampled between 2016 and 2018 (Table 10). A summary of NWLP contaminant monitoring locations and species analyzed as edible portion samples between 1980 and 2019 is provided in Appendix B2.

Mercury was assayed in the six NWLP populations and concentrations exceeded MDHHS screening values in all six. Mercury is the primary cause of consumption advisories in all six populations.

PCBs and the standard suite of halogenated organic contaminants were assayed in fish from Portage and Manistee Lakes (Manistee County). PCBs without the other halogenated contaminants were analyzed in brown trout from the Hersey River (Osceola County). PCB concentrations exceeded MDHHS screening values in Manistee Lake black crappie and Portage Lake largemouth bass.

Apparent toxaphene was assayed in 55 NWLP fish populations between 2016 and 2019. Toxaphene is a primary contaminant causing consumption advisories in one population (Glen Lake [Leelanau County] lake trout) and a secondary contaminant in three other NWLP

fish populations. Apparent toxaphene concentrations did not exceed the LOQ in 51 of the NWLP datasets.

PFCs were analyzed in largemouth bass from Manistee Lake. PFOS concentrations did not exceed MDHHS screening values.

Dioxin TEQ and selenium were not assayed in the samples collected from the NWLP between 2016 and 2018.

3.3.3 Northeast Lower Peninsula (NELP)

Seventeen fish populations comprised of 11 species from eight water bodies in the NELP were sampled between 2016 and 2018 (Table 10). A summary of NELP contaminant monitoring locations and species analyzed as edible portion samples between 1980 and 2019 is provided in Appendix B3.

Mercury was assayed in all 17 NELP fish populations sampled and concentrations exceeded MDHHS screening values in all populations except for bluegill and pumpkinseed from Lake Margrethe (Crawford County).

PCBs and the standard suite of halogenated organic contaminants were assayed in six NELP fish populations including brown trout from the Au Sable River near Grayling (Crawford County), smallmouth bass from the Au Sable at Oscoda (Iosco County), northern pike from Mullett Lake (Cheboygan County), northern pike and walleye from Lake Winyah (Alpena County), and walleye from Van Etten Lake (Iosco County). PCB concentrations in the Au Sable River brown trout exceeded MDHHS screening values.

Apparent toxaphene was assayed in 33 NELP fish populations between 2016 and 2019; concentrations did not exceed the LOQ in any of those datasets.

PFCs were assayed in 14 of the NELP fish populations. PFOS concentrations exceeded MDHHS screening values in Au Sable River (at Oscoda) smallmouth bass, Lake Margrethe bluegill, pumpkinseed, and largemouth bass, and Van Etten Lake black crappie, largemouth bass, northern pike, smallmouth bass, and walleye.

Dioxin TEQ and selenium were not assayed in NELP fish populations between 2016 and 2018.

3.3.4 Southwest Lower Peninsula (SWLP)

A total of 83 fish populations comprised of 16 species from 42 SWLP water bodies were sampled between 2016 and 2019 (Table 10). A summary of SWLP contaminant monitoring locations and species analyzed as edible portion samples between 1980 and 2019 is provided in Appendix B4.

Mercury was assayed in all of the SWLP fish populations sampled between 2016 and 2019 and is a primary cause of consumption advice in 64% of those populations. Mercury would cause consumption advisories in 88% of the SWLP fish populations sampled if it was the only contaminant of concern.

Total PCBs were assayed in 39 of the SWLP fish populations sampled between 2016 and 2019. PCBs are a primary cause of consumption advice in 8 (20%) of the populations sampled and would cause a consumption advisory in 23 (59%) of the fish populations if it was the only contaminant of concern.

Total DDT was assayed in 38 of the SWLP fish populations sampled between 2016 and 2019 and was a primary cause of consumption advice only in bluegill, largemouth bass, and smallmouth bass from the St. Louis Impoundment of the Pine River (Gratiot County). DDT would also cause a consumption advisory in carp from the Grand River downstream of Webber Dam if it was the only contaminant of concern.

Apparent toxaphene was assayed in 38 SWLP fish populations between 2016 and 2019; concentrations exceeded MDHHS screening values in one population (Muskegon Lake largemouth bass). Concentrations were below the LOQ in all other datasets.

Dioxin TEQ was assayed in six SWLP fish populations sampled between 2016 and 2019 and is the primary cause of consumption advice for carp from the Kalamazoo River between the Marshall Dam and Morrow Dam (Calhoun and Kalamazoo Counties). Dioxin TEQ concentrations in rock bass and white sucker from the Chippewa River at Mt. Pleasant (Isabella County) did not exceed MDHHS screening values.

PFCs were assayed in 69 fish populations from 34 water bodies sampled between 2016 and 2019. PFOS is the primary contaminant causing consumption advice in 18 (26%) of those populations and would cause a consumption advisory in 34 (49%) of the fish populations if it was the only contaminant of concern.

Selenium was not assayed in samples collected from SWLP water bodies between 2016 and 2019.

3.3.5 Southeast Lower Peninsula (SELP)

A total of 55 fish populations comprised of ten species from 28 SELP water bodies were sampled between 2016 and 2019 (Table 10). A summary of SELP contaminant monitoring locations and species analyzed as edible portion samples between 1980 and 2019 is provided in Appendix B5.

Mercury was assayed in all of the SELP fish populations sampled between 2016 and 2019 and is a primary cause of consumption advice in 24 (44%) of those populations. Mercury would cause consumption advisories in 43 (78%) of the SELP fish populations sampled if it was the only contaminant of concern.

Total PCBs were assayed in 26 of the SELP fish populations sampled between 2016 and 2019. PCBs are a primary cause of consumption advice in four (15%) of the fish populations sampled and would cause advisories in 13 (50%) of the populations if it was the only contaminant of concern.

Total DDT was assayed in 26 of the SELP fish populations sampled between 2016 and 2019 and was not a primary cause of consumption advice in any of the sample sets. Total DDT would cause consumption advisories in one (4%) of the SELP fish populations sampled if it was the only contaminant of concern.

Apparent toxaphene was assayed in 26 SELP fish populations between 2016 and 2019; concentrations did not exceed the LOQ in any of those datasets.

PFCs were assayed in 53 SELP fish populations between 2016 and 2019. PFOS was a primary cause of consumption advisories in 24 (45%) of the populations sampled and would cause advisories in 36 (68%) of the populations sampled if it was the only contaminant of concern.

Dioxin TEQ and selenium were not assayed in SELP fish populations sampled between 2016 and 2019.

3.4 Summary of Sampling and Screening Value Comparisons for the Great Lakes and Connecting Channels Analyzed in FYs 2017-2019

This section discusses analytical results for mercury, total PCBs, total DDT, toxaphene (as either apparent toxaphene or Tox Σ3PC), dioxin TEQ, PFOS, and selenium assays conducted on samples collected in 2016, 2017, and 2018 from the Great Lakes and connecting channels and analyzed in FYs 2017-2019. These are the contaminants with screening values developed by the MDHHS.

3.4.1 Lake Superior

Edible portion samples of four populations comprised of four species from a total of five Lake Superior locations were collected in 2016 and 2018 (Table 11). Lake whitefish were collected from three areas in 2016 (off Grand Marais in eastern Lake Superior, off Marquette in central Lake Superior, and off 10-Mile Point west of the Keweenaw Peninsula), rainbow smelt were collected in 2016 from the Elm River (northeast of Ontonagon), and northern pike and walleye were collected in 2018 from Huron Bay (east of Keweenaw Bay). A summary of Lake Superior species analyzed as edible portion samples between 1980 and 2019 is provided in Appendix C.

Mercury was assayed in all samples and concentrations in all four populations exceeded MDHHS screening values. Mercury is the primary contaminant causing consumption advisories in Lake Superior northern pike, rainbow smelt, and northern pike, and is a secondary contaminant in lake whitefish.

Total PCB was assayed in all four Lake Superior populations and is a secondary cause of consumption advice for walleye and lake whitefish. PCB concentrations in the northern pike and rainbow smelt did not exceed MDHHS screening values.

Total DDT was assayed in all four Lake Superior populations and concentrations did not exceed MDHHS screening values.

Apparent toxaphene was assayed in the Lake Superior northern pike, rainbow smelt, and walleye. Concentrations did not exceed the LOQ for those populations.

Tox Σ3PC was assayed in the Lake Superior lake whitefish. Concentrations exceeded MDHHS screening values and Tox Σ3PC is a secondary cause of consumption advice for the species.

Dioxin TEQ was assayed in the Lake Superior lake whitefish and is the primary cause of consumption advice for that population.

PFCs were assayed in the Lake Superior lake whitefish and PFOS concentrations exceeded MDHHS screening values. PFOS is a secondary cause of consumption advice for that population.

Selenium was not assayed in Lake Superior samples in FYs 2016-2019.

3.4.2 St. Marys River

Ten yellow perch collected from the Munuscong River, a tributary to the St. Marys River, were collected in 2018 and analyzed for mercury, the standard suite of halogenated organic contaminants, and PFCs (Table 11). The Munuscong River results were combined to earlier results for yellow perch from the St. Marys River for the Eat Safe Fish evaluation. A summary of St. Marys River species analyzed as edible portion samples between 1980 and 2019 is provided in Appendix C.

Mercury is the only contaminant assayed that causes a consumption advisory for Munuscong River/St. Marys River yellow perch. Total PCBs, DDT, apparent toxaphene were all below the respective QL.

The PFOS concentration in all ten Munuscong River yellow perch were less than the MDHHS screening values.

Dioxin TEQ and selenium have not been assayed in St. Marys River yellow perch.

3.4.3 Lake Michigan

Three Lake Michigan fish populations were sampled in 2016 and 2017 (Table 11). Lake whitefish were collected from two areas in 2016 (Grand Traverse Bay and the southern basin). In 2017 coho salmon were collected from Belmont Creek (a tributary to the Rogue River, Kent County) and rainbow trout (steelhead) were collected from the Grand River at the Webber Dam (Ionia County). A summary of Lake Michigan species analyzed as edible portion samples between 1980 and 2019 is provided in Appendix C.

Mercury was assayed in all samples. Concentrations exceeded MDHHS screening values and mercury is a secondary contaminant causing consumption advisories in all three populations.

Total PCB was assayed in all samples. Concentrations exceeded MDHHS screening values and total PCB is a primary contaminant causing consumption advisories in all three populations.

Total DDT was assayed in all samples. Concentrations exceeded MDHHS screening values in the rainbow trout. Total DDT is a secondary contaminant in that population.

Apparent toxaphene was assayed in the Lake Michigan coho salmon and rainbow trout. Concentrations did not exceed the LOQ for those populations.

Tox Σ3PC was assayed in the Lake Michigan lake whitefish. Concentrations did not exceed MDHHS screening values.

Dioxin TEQ was assayed in the Lake Michigan lake whitefish and is a primary cause of consumption advice for that population.

PFCs were assayed in all three Lake Michigan populations. PFOS concentrations did not exceed MDHHS screening values in the coho salmon and lake whitefish. The PFOS concentration exceeded screening values in the rainbow trout and is a secondary cause of consumption advice for that population.

Selenium was not assayed in any of the Lake Michigan samples in FYs 2016-2019.

3.4.4 Lake Huron

Three Lake Huron fish populations were sampled in 2016 and 2018 (Table 11). Lake whitefish were collected from two areas in 2016 (northern Lake Huron near the Les Cheneaux Islands and central Lake Huron off Oscoda). In 2018 Atlantic salmon were collected from the Au Sable River at Oscoda (Iosco County) and yellow perch were collected from northern Lake Huron near the Les Cheneaux Islands. A summary of Lake Huron species analyzed as edible portion samples between 1980 and 2019 is provided in Appendix C.

Mercury was assayed in all samples and exceeded MDHHS screening values in the lake whitefish and yellow perch. Mercury is a secondary cause of consumption advisories in those two populations.

Total PCB was assayed in all samples. Concentrations exceeded MDHHS screening values and PCBs are a secondary cause of consumption advisories in all three populations.

Total DDT was assayed in all three populations. Concentrations did not exceed MDHHS screening values in any of the populations sampled.

Apparent toxaphene was assayed in the Lake Huron Atlantic salmon and yellow perch. Concentrations did not exceed the LOQ for those populations.

Tox Σ3PC was assayed in the Lake Huron lake whitefish. Concentrations did not exceed MDHHS screening values.

Dioxin TEQ was assayed in the Lake Huron Atlantic salmon and lake whitefish and is the primary cause of consumption advice for both populations. Dioxin TEQ is the primary cause of consumption advice for yellow perch based on analysis of samples collected in 2004 from Saginaw Bay.

PFCs in Lake Huron Atlantic salmon and lake whitefish were assayed. PFOS concentrations did not exceed MDHHS screening values in either population.

Selenium was not assayed in any of the Lake Huron samples in FYs 2016-2019.

3.4.5 St. Clair River

Four St. Clair River fish populations were sampled in 2016 and 2018 (Table 11). Carp, largemouth bass, and rock bass were collected in 2016. Yellow perch were collected in both 2016 and 2018 (Table 11). A summary of St. Clair River species analyzed as edible portion samples between 1980 and 2019 is provided in Appendix C.

Mercury was assayed in all samples and concentrations exceeded MDHHS screening values in all four populations. Mercury is the primary contaminant causing consumption advisories in St. Clair River largemouth bass, rock bass, and yellow perch, and is a secondary contaminant in St. Clair River carp.

Total PCB was assayed in all four St. Clair River populations. PCB concentrations exceeded MDHHS screening values in St. Clair River carp and largemouth bass, and is the primary cause of consumption advice for carp. PCB concentrations in rock bass and yellow perch did not exceed MDHHS screening values.

Total DDT was assayed in all four St. Clair River populations. Concentrations in carp exceeded MDHHS screening values and DDT is a secondary cause of consumption advice in that population. Total DDT concentrations in largemouth bass, rock bass, and yellow perch did not exceed the screening values.

Apparent toxaphene was assayed in all four St. Clair River populations. Concentrations did not exceed the LOQ for any of the four species.

PFCs were assayed in the St. Clair River carp, largemouth bass, and rock bass. PFOS concentrations exceeded MDHHS screening values in the largemouth bass and rock bass and is a secondary contaminant causing consumption advisories for those species.

Dioxin TEQ and selenium were not assayed in any of the St. Clair River samples in FYs 2016-2019.

3.4.6 Lake St. Clair

Bluegill and largemouth bass were collected from Anchor Bay and L'Anse Creuse Bay in Lake St. Clair in 2017 (Table 11) and analyzed in FY 2018. A summary of Lake St. Clair species analyzed as edible portion samples between 1980 and 2019 is provided in Appendix C.

Both mercury and total PCB were assayed in all samples and concentrations of both contaminants exceeded MDHHS screening values in bluegill and largemouth bass. Both mercury and PCBs were the primary contaminants causing consumption advice for the largemouth bass and were secondary contaminants in the bluegill.

Total DDT was assayed in all the Lake St. Clair samples and concentrations did not exceed MDHHS screening values in either bluegill or largemouth bass.

Apparent toxaphene was assayed in both Lake St. Clair populations. Concentrations did not exceed the LOQ for either the bluegill or largemouth bass.

PFCs were assayed in the Lake St. Clair bluegill and largemouth bass. PFOS concentrations exceeded MDHHS screening values in both populations. PFOS is the primary contaminant causing consumption advice for bluegill and is a secondary contaminant in largemouth bass.

Dioxin TEQ and selenium were not assayed in the Lake St. Clair River bluegill or largemouth bass samples collected in 2017.

3.4.7 Detroit River

Largemouth bass, northern pike, white bass, and yellow perch were collected from the Detroit River, Trenton Channel, in 2016 and analyzed in FY 2017 (Table 11). A summary of Detroit River species analyzed as edible portion samples between 1980 and 2019 is provided in Appendix C.

Mercury was assayed in all samples. Concentrations exceeded MDHHS screening values in all four populations and is a primary contaminant causing consumption advisories in northern pike and yellow perch. Mercury is a secondary contaminant in in largemouth bass and white bass.

Total PCB was assayed in all samples and concentrations exceeded MDHHS screening values in all four populations. PCBs are a primary cause of consumption advisories in Detroit River

largemouth bass, white bass, and yellow perch, and a secondary cause of consumption advice for northern pike.

Total DDT and apparent toxaphene were assayed in all four Detroit River fish populations sampled in 2016. Concentrations of both contaminants were below MDHHS screening values in all four populations.

Dioxin TEQ was assayed in the Detroit River largemouth bass, northern pike, and white bass collected in 2016. Dioxin TEQ is a secondary cause of consumption advice for those three populations.

PFCs were assayed in the Detroit River largemouth bass and yellow perch. PFOS concentrations exceeded MDHHS screening values and PFOS is a secondary cause of consumption advice for both species.

Selenium has not been assayed in Detroit River fish populations.

3.4.8 Lake Erie

Carp and largemouth bass were collected from the River Raisin near the river mouth at Monroe (Monroe County) in 2016 (Table 11). Sample results were combined with results for those species collected from Lake Erie in previous years under the assumption that individuals of those species are likely to move between the lake and the river. A summary of Lake Erie species analyzed as edible portion samples between 1980 and 2019 is provided in Appendix C.

Mercury was assayed in all samples and concentrations in both populations exceeded MDHHS screening values. Mercury is a secondary contaminant causing consumption advisories in Lake Erie carp and largemouth bass.

Total PCB was assayed in all samples and concentrations in both populations exceeded MDHHS screening values. PCBs are the primary contaminant causing consumption advisories in Lake Erie carp and largemouth bass.

Total DDT was assayed in all samples. Concentrations in carp populations exceeded MDHHS screening values. DDT is a secondary contaminant causing consumption advisories in Lake Erie carp.

Apparent toxaphene was assayed in both Lake Erie populations. Concentrations did not exceed the LOQ for either the carp or largemouth bass.

Dioxin TEQ was assayed in both the Lake Erie carp and largemouth bass collected in 2016. Dioxin TEQ exceeded MDHHS screening values and is a secondary cause of consumption advice for both populations.

PFCs and selenium were not assayed in the Lake Erie carp and largemouth bass samples collected in 2016.

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SECTION 4.0

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Table 1. Standard edible portions of Michigan's sport and commercial fishes.

Standard Edible Portion	Common Name	Scientific Name
Skin-on Fillet	Yellow Perch	*Perca flavescens*
	Walleye	*Sander vitreus*
	Sauger	*Sander canadensis*
	Largemouth Bass	*Micropterus salmoides*
	Smallmouth Bass	*Micropterus dolomieu*
	Bluegill	*Lepomis macrochirus*
	Pumpkinseed	*Lepomis gibbosus*
	Rock Bass	*Ambloplites rupestris*
	White Bass	*Morone chrysops*
	Black Crappie	*Pomoxis nigromaculatus*
	White Crappie	*Pomoxis annularis*
	Green Sunfish	*Lepomis cyanellus*
	Longear Sunfish	*Lepomis megalotis*
	Warmouth	*Lepomis gulosus*
	White Sucker	*Catastomus commersonii*
	Redhorse Sucker	*Moxostoma* spp.
	Lake Whitefish	*Coregonus clupeaformis*
	Lake Trout (lean & ciscowet)	*Salvelinus namaycush*
	Rainbow Trout (Steelhead)	*Oncorhynchus mykiss*
	Brown Trout	*Salmo trutta*
	Brook Trout	*Salvelinus fontinalis*
	Splake	*Salvelinus fontinalis* X *Salvelinus namaycush*
	Atlantic Salmon	*Salmo salar*
	Coho Salmon	*Oncorhynchus kisutch*
	Chinook Salmon	*Oncorhynchus tschawytscha*
	Pink Salmon	*Oncorhynchus gorbuscha*
Skin-off Fillet	Black Bullhead	*Ameiurus melas*
	Brown Bullhead	*Ameiurus nebulosus*
	Yellow Bullhead	*Ameiurus natalis*
	Channel Catfish	*Ictalurus punctatus*
	Muskellunge	*Esox masquinongy*
	Northern Pike	*Esox lucius*
	Round Whitefish (Menominee)	*Prosopium cylindraceum*
	Lake Herring	*Coregonus artedii*
	Chubs	*Coregonus sp*
	Carp	*Cyprinus carpio*
	Freshwater Drum (Sheepshead)	*Aplodinotus grunniens*
	Buffalo	*Ictiobus cyprinellus*
	Burbot	*Lota lota*
	Quillback	*Carpiodes cyprinus*
Skin-off Steak	Lake Sturgeon	*Acipenser fulvescens*
Headless, Gutted	Rainbow Smelt	*Osmerus mordax*

Table 2. Contaminants quantitated in edible portion fish tissue samples.

Contaminant	Level of Quantitation
Hexachlorobenzene	0.001 ppm
gamma-BHC (Lindane)	0.001 ppm
Aldrin	0.001 ppm
Dieldrin	0.001 ppm
4,4'-DDE	0.001 ppm
4,4'-DDD	0.001 ppm
4,4'-DDT	0.001 ppm
2,4'-DDE	0.001 ppm
2,4'-DDD	0.001 ppm
2,4'-DDT	0.001 ppm
Heptachlor Epoxide	0.001 ppm
Mercury	0.010 ppm
Selenium	0.010 ppm
Oxychlordane	0.001 ppm
gamma-Chlordane	0.001 ppm
trans-Nonachlor	0.001 ppm
alpha-Chlordane	0.001 ppm
cis-Nonachlor	0.001 ppm
Octachlorostyrene	0.001 ppm
Hexachlorostyrene	0.001 ppm
Heptachlorostyrene	0.001 ppm
Pentachlorostyrene	0.001 ppm
Heptachlor	0.001 ppm
Terphenyl	0.250 ppm
Apparent Toxaphene	0.050 ppm
Toxaphene $\Sigma 3PC_{26,50,62}$	0.050 ppb
Mirex	0.001 ppm
PBB (FF-1, BP-6)	0.001 ppm
Total PCB (congener method)	0.001 ppm

Table 3. PCB structure and corresponding identification number of congeners quantitated in fish tissue samples.

BZ#	Structure
	TRICHLOROBIPHENYLS
17	2,2',4
18	2,2',5
22	2,3,4'
25	2,3',4
26	2,3',5
28	2,4,4'
31	2,4',5
32	2,4',6
33	2',3,4
37	3,4,4'
	TETRACHLOROBIPHENYLS
40	2,2',3,3'
42	2,2',3,4'
44	2,2',3,5'
45	2,2',3,6
47	2,2',4,4'
49	2,2',4,5'
52	2,2',5,5'
56	2,3,3',4'
60	2,3,4,4'
63	2,3',4',5
64	2,3,4',6
66	2,3',4,4'
70	2,3',4',5
71	2,3',4',6
74	2,4,4',5
77	3,3',4,4'
	PENTACHLOROBIPHENYLS
82	2,2',3,3',4
84	2,2',3,3',6
87	2,2',3,4,5'
90	2,2',3,4',5
91	2,2',3,4',6
92	2,2',3,5,5'
95	2,2',3,5',6
97	2,2',3',4,5
99	2,2',4,4',5
100	2,2',4,4',6
101	2,2',4,5,5'
105	2,3,3',4,4'
110	2,3,3',4',6
118	2,3',4,4',5
126	3,3',4,4',5

BZ#	Structure
	HEXACHLOROBIPHENYLS
128	2,2',3,3',4,4'
130	2,2',3,3',4,5'
132	2,2',3,3',4,6'
135	2,2',3,3',5,6'
136	2,2',3,3',6,6'
137	2,2',3,4,4',5
138	2,2',3,4,4',5'
141	2,2',3,4,5,5'
144	2,2',3,4,5',6
146	2,2',3,4',5,5'
149	2,2',3,4',5',6
151	2,2',3,5,5',6
153	2,2',4,4',5,5'
156	2,3,3',4,4',5
157	2,3,3',4,4',5'
158	2,3,3',4,4',6
163	2,3,3',4',5,6
167	2,3',4,4',5,5'
	HEPTACHLOROBIPHENYLS
170	2,2',3,3',4,4',5
171	2,2',3,3',4,4',6
172	2,2',3,3',4,5,5'
174	2,2',3,3',4,5,6'
175	2,2',3,3',4,5',6
177	2,2',3,3',4',5,6
178	2,2',3,3',5,5',6
179	2,2',3,3',5,6,6'
180	2,2',3,4,4',5,5'
182	2,2',3,4,4',5,6'
183	2,2',3,4,4',5',6
185	2,2',3,4,5,5',6
187	2,2',3,4',5,5',6
190	2,3,3',4,4',5,6
193	2,3,3',4',5,5',6
	OCTACHLOROBIPHENYLS
194	2,2',3,3',4,4',5,5'
195	2,2',3,3',4,4',5,6
196	2,2',3,3',4,4',5,6'
198	2,2',3,3',4,5,5',6
199	2,2',3,3',4,5,6,6'
201	2,2',3,3',4,5,5',6'
203	2,2',3,4,4',5,5',6
205	2,3,3',4,4',5,5',6
	NONACHLOROBIPHENYLS
206	2,2',3,3',4,4',5,5',6

BZ# = identification numbers adopted by the International Union of Pure and Applied Chemists (IUPAC).

Table 4a. Chlorinated dibenzo-p-dioxin (CDD) and chlorinated dibenzofuran (CDF) congeners quantitated in selected fish tissue samples.

CDD	Level of Quantitation
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1.0 ppt
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PCDD)	1.0 ppt
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	1.0 ppt
1,2,3,6,7,8-HxCDD	1.0 ppt
1,2,3,7,8,9-HxCDD	1.0 ppt
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	1.0 ppt
1,2,3,4,6,7,8,9,-Octachlorodibenzo-p-dioxin (OCDD)	1.0 ppt
CDF	
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	1.0 ppt
1,2,3,7,8-Pentachlorodibenzofuran (PCDF)	1.0 ppt
2,3,4,7,8-PCDF	1.0 ppt
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	1.0 ppt
1,2,3,6,7,8-HxCDF	1.0 ppt
1,2,3,7,8,9-HxCDF	1.0 ppt
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	1.0 ppt
1,2,3,4,7,8,9-HpCDF	1.0 ppt
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	1.0 ppt

Table 4b. Coplanar PCB congeners analyzed quantitated in selected fish tissue samples.

BZ#	Structure		Quantitation Level (ppt)
	TETRACHLOROBIPHENYLS		
077		3,3'4,4'	50.0
081		3,4,4',5	50.0
	PENTACHLOROBIPHENYLS		
105		2,3,3',4,4'	50.0
114		2,3,4,4',5	50.0
118		2,3',4,4',5	50.0
123		2',3,4,4',5	50.0
126		3,3',4,4',5	50.0
	HEXACHLOROBIPHENYLS		
156		2,3,3',4,4',5	50.0
157		2,3,3',4,4',5'	50.0
167		2,3',4,4',5,5'	50.0
169		3,3',4,4',5,5'	50.0
	HEPTACHLOROBIPHENYLS		
189		2,3,3',4,4',5,5'	50.0

BZ# = identification numbers adopted by the International Union of Pure and Applied Chemists (IUPAC).

Table 5. Perfluorinated compounds quantitated in selected fish tissue samples.

Compound	Level of Quantitation (ppb)
Perfluorodecanoic acid	1
Perfluorododecanoic acid	1
Perfluorohexane sulfonate	1
Perfluorononanoic acid	1
Perfluorooctanoic acid	1
Perfluorooctane sulfonate	1
Perfluorooctanesulfonamide	1
Perfluorotridecanoic acid	1
Perfluoroundecanoic acid	1
Perfluorobutanoic acid*	1
Perfluoropentanoic acid*	1
Perfluorohexanoic acid*	1
Perfluoroheptanoic acid*	1
Perfluorotetradecanoic acid	1
Perfluorobutane sulfonate*	1
Perfluorodecane sulfonate	1

* - generally not reported by the MDHHS-ACL

Table 6. Michigan Department of Health and Human Services Fish Consumption Screening Values for DDT plus metabolites, dioxin-like chemicals, mercury, PCBs, PFOS, selenium, and toxaphene.

Meal Category	**DDT, DDE, DDD**	**Dioxins/Furans & co-planar PCBs**	**Mercury**	**PCBs**
meals per month	*µg/g (ppm)*	*pg TEQ/g (ppt-TEQ)*	*µg/g (ppm)*	*µg/g (ppm)*
16	≤ 0.11	≤ 0.5	≤ 0.07	≤ 0.01
12	>0.11 to 0.15	>0.5 to 0.6	>0.07 to 0.09	>0.01 to 0.02
8	>0.15 to 0.23	>0.6 to 0.9	>0.09 to 0.13	>0.02 to 0.03
4	>0.23 to 0.45	>0.9 to 1.9	>0.13 to 0.27	>0.03 to 0.05
2	>0.45 to 0.91	>1.9 to 3.7	>0.27 to 0.53	>0.05 to 0.11
1	>0.91 to 1.8	>3.7 to 7.5	>0.53 to 1.1	>0.11 to 0.21
6 meals per year	>1.8 to 3.7	>7.5 to 15	>1.1 to 2.2	>0.21 to 0.43
Limited	>3.7 to 20	>15 to 90	NA	>0.43 to 2.7
Do Not Eat	>20	>90	>2.2	>2.7

Meal Category	**PFOS (provisional)**	**Selenium**	**Total "Apparent" Toxaphene**	**Toxaphene Parlars 26, 50, 62 (Σ3PC26,50,62)**
meals per month	*µg/g (ppm)*	*µg/g (ppm)*	*µg/g (ppm)*	*µg/g (ppm)*
16	≤ 0.009	≤ 2.3	≤ 0.02	≤ 0.001
12	>0.009 to 0.013	>2.3 to 3.1	>0.02 to 0.03	>0.001 to 0.002
8	>0.013 to 0.019	>3.1 to 4.6	>0.03 to 0.05	>0.002 to 0.003
4	>0.019 to 0.038	>4.6 to 9.2	>0.05 to 0.09	>0.003 to 0.006
2	>0.038 to 0.075	>9.2 to 17	>0.09 to 0.18	>0.006 to 0.011
1	>0.075 to 0.15	NA	>0.18 to 0.36	>0.011 to 0.023
6 meals per year	>0.15 to 0.3	NA	>0.36 to 0.73	>0.023 to 0.046
Limited	NA	NA	>0.73 to 4.5	>0.046 to 0.28
Do Not Eat	>0.3	>17	>4.5	>0.28

[two tables as pdfs]

Table 7. Number of edible portion fish contaminant monitoring events by water body type, 1980 through 2019.

Table 8. Total number of edible portion fish contaminant sampling sites by water body type, 1980 through 2019.

Table 9. Summary of chemicals quantitated in edible portion fish tissue samples analyzed in FYs 2017-2019.

Chemical	# of Sites Monitored	# of Sites Quantitated	Concentration Range (ppm except as noted)	Location and Species with Maximum Concentration
Aldrin	77	2	K0.001 – 0.001	Kalamazoo River, d/s Calkin Dam, Carp
Apparent Toxaphene	68	0	K0.05	no measurable concentrations
Dieldrin	27	10	K0.001 – 0.03	River Raisin, Monroe, Carp
Dioxin TEQ*	16	16	0.02 – 69 ppt	Kalamazoo River, d/s Calkin Dam, Carp
gamma-BHC (Lindane)	65	4	K0.001 – 0.001	Grand River, d/s Grand Rapids, Channel Catfish
Heptachlor	77	0	K0.001	no measurable concentrations
Heptachlor Epoxide	68	11	K0.001 – 0.01	Lake Superior, 10-Mile Point, Lake Whitefish
Heptachlorostyrene	68	2	K0.001 – 0.001	Lake Michigan, Southern, Lake Trout
Hexachlorobenzene	68	28	K0.001 – 0.005	Lake Michigan, Southern, Lake Trout
Hexachlorostyrene	68	2	K0.001 – 0.001	Lake Michigan, Southern, Lake Trout
Mercury	126	126	0.01 - 3.2	Lake Michigamme, Marquette Co., Northern Pike
Mirex	68	12	K0.001 – 0.05	River Raisin, Monroe, Carp
Nickel	3	0	K0.8	no measurable concentrations
Octachlorostyrene	68	13	K0.001 – 0.03	River Raisin, Monroe, Carp
PBB	76	3	K0.001 – 0.003	River Raisin, Monroe, Carp
Pentachlorostyrene	68	2	K0.001 – 0.001	Lake Michigan, Southern, Lake Trout
PFOS	93	93	K0.25 – 1,998 ppb	Kent Lake, Oakland Co., Largemouth Bass
Selenium	2	2	0.14 – 0.78	Milwaukee Lake, Marquette Co., Bluegill
Terphenyl	68	0	K0.25	no measurable concentrations
Total Chlordane	68	41	K0.001 – 0.09	Lake Michigan, Southern, Lake Trout
Total DDT	68	64	K0.001 – 0.90	River Raisin, Monroe, Carp
Total PCB	77	64	K0.001 – 15.8	River Raisin, Monroe, Carp
Toxaphene 3PC26,50,62	5	5	0.16 – 37.1	Lake Superior, Munising, Lake Trout

K = Concentrations below the level shown (quantitation or detection limit)
* = TEQ calculated based on 2005 World Health Organization TEFs, including co-planar PCBs.

Table 10. Inland waters summary 2019 (pdf)

Table 11. GLCC waters summary 2019 (pdf)

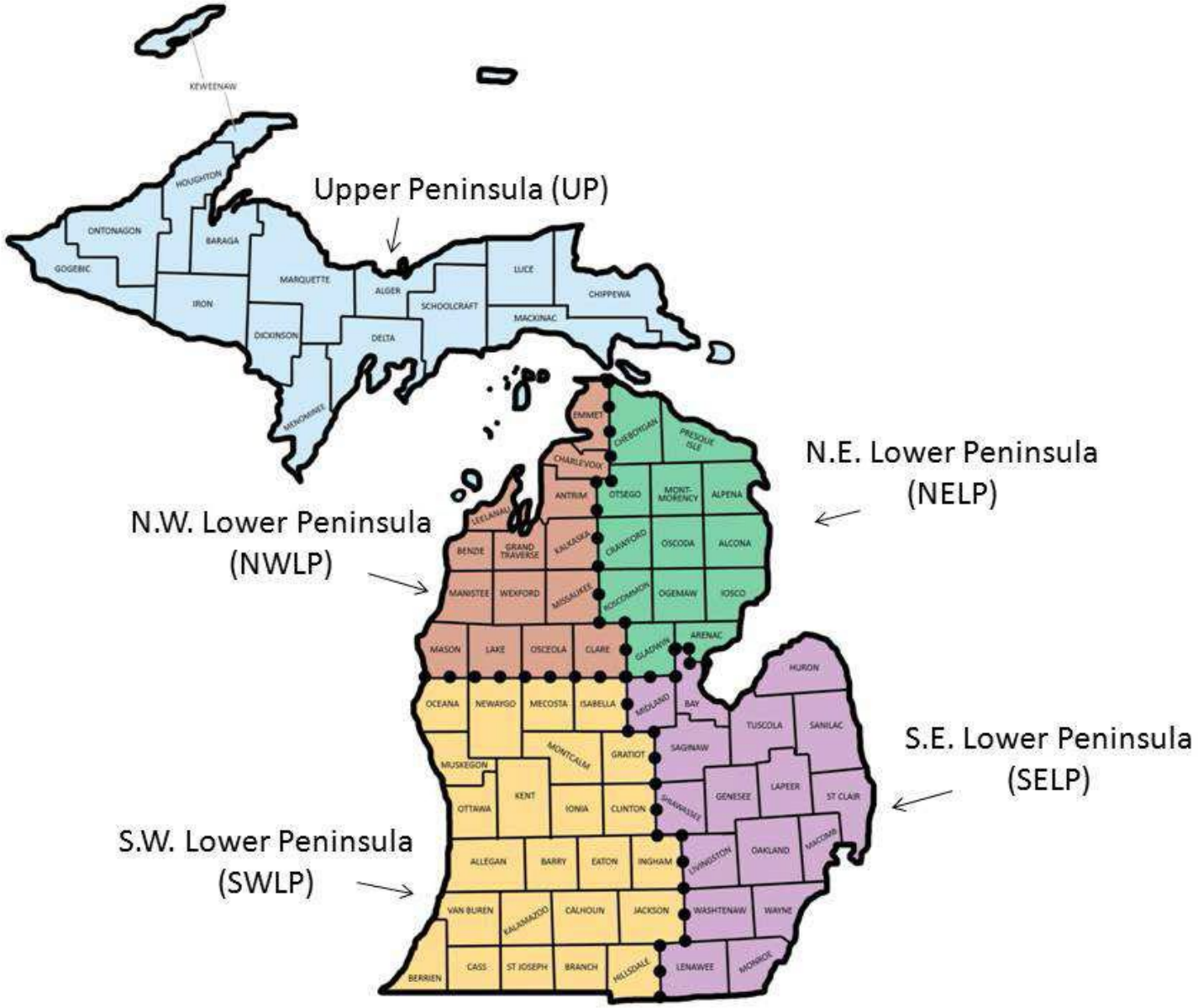

Figure 1. Five regions of Michigan used in the Department of Health and Human Services "Eat Safe Fish Guide."

LIST OF APPENDICES